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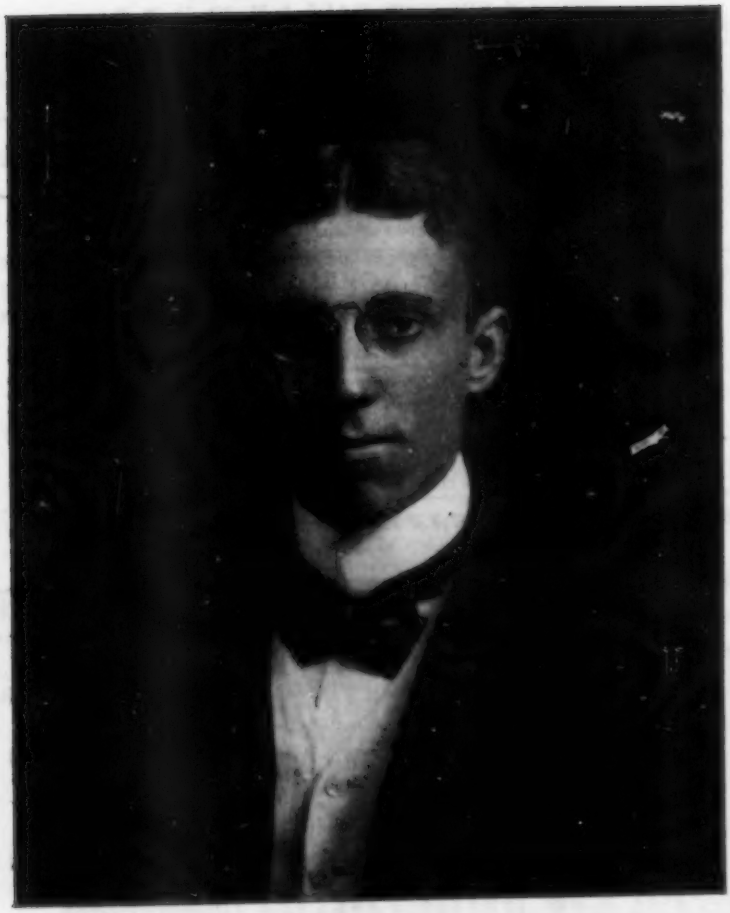

H. L. SAYEN

Inventor of the Queen X-Ray Tube

THE AMERICAN
X-RAY JOURNAL
Devoted to Practical X-Ray Work and Allied Arts and Sciences.

VOL. XV. CHICAGO, NOVEMBER, 1904. No. 5

Report on N-Rays.*

BY ANDRE BROCA.

PHYSICAL PROPERTIES.

These rays traverse for the most part bodies opake to light; aluminum, paper, pasteboard, wood. But certain substances are opake; these are pure water, which is opake at a very slight depth; lead, which is opake if 0.2 mm. in thickness; platinum, when 0.4 mm. in thickness. Glass is quite opake, altho considerably less so than the preceding bodies. A very curious fact is that salt water permits them to pass, altho pure water is opake.

The n-rays are stored up in the bodies which they strike in certain cases. Quartz, Iceland spar, glass, brick, sulfid of calcium, lead and salt water possess this property; wood, paper, aluminum, do not possess this property. When the action of the source ceases, the bodies thus exposed emit n-rays for a longer or shorter time.

This fact is quite analogous to the phosphorescence of certain bodies under the action of sunlight. Bichat has shown a very close similarity in the details of these phenomena.

It is a fact that a body which stores up n-rays when heated will quickly lose this property on the temperature becoming lower. At the same time, if analyzed by means of a prism, after the method of Blondlot, which we have described elsewhere, the radiations emitted by a body which has stored up n-rays always gives radiations much greater in wave length than the radiations which have not been stored. The expression "store up," used to designate this phenomenon, is not the most appropriate, for it refers to a transformation in the secondary rays analagous to that which light undergoes in phosphorescence or fluorescence, analogous also to that which the x-rays undergo at the surface of bodies which they strike. We retain, however, the expression "store up," employed by Blondlot to designate the phenomenon, and which has the advantage that it enables one to thoroly grasp the existence of the relatively considerable delay which is frequently observed in the perception of n-rays.

Bodies opake to n-rays, like lead, store them up to a greater depth the longer they have been exposed. Frequently the delay of the discharge is very prominent in observation of n-rays. For the purpose of reducing this to a minimum one ought to use as a phosphorescent screen a layer of sulfid of calcium as thin as possible; for the sulfid displays with great intensity the phenomenon of storing up. It also is necessary to keep in mind this fact of

*Translated from Archives d'Electricité Médicale by J. Z. S. Haywood, D.-es-Sc., continued from page 296.

storing up when studying n-rays, else the observations would frequently be vitiated thru the use of screens which store up the rays. Screens of lead would occasionally give room for the gravest mistakes, for they themselves would be the sources either of n-rays, or n_1-rays. I myself have seen screens of lead which normally emitted at their surfaces n-rays from certain points and n_1-rays from other points.

The n-rays enjoy the property of self-reflection and self-refraction. When one takes a prism of aluminum and lets fall upon it a bundle of rays limited by two parallel plates of lead situated a certain distance apart, a considerable dispersion is observed in the emerging bundle of rays, manifested by the existence of sufficiently clear bands. Blondlot has been able to measure the mean indices, and he has found likewise, in the emission of a Nernst lamp, studied by means of an aluminum prism of 30 degrees and a screen of sulfid, the existence of eight distinct radiations. With a prism of 90 degrees he has been able to separate the least refrangible radiations. These include eleven radiations which pass thru aluminum. Afterward he was able, by employing ordinary grating, to measure the wave length of the rediations thus isolated.

A remarkable fact noted, which would not be marvelous in another place, is that the n-rays have much greater refraction indices when their wave length, measured with the screen (grating), are the greatest. It should be remarked that aluminum gives, for these radiations, an anomalous dispersion. This is not extraordinary, because this metal absorbs considerable of the luminous and ultra-violet radiations, and the anomalous dispersion is correlative with the absorption of the parts of the spectrum near those shown.

All these facts are summed up in the following table:

Length of Undulation in Bicrons (thousandth of a Micron.)	Refractive Index for Aluminum.	Nature of the Rays.
3	1.004	n_1
4.8	1.0064	n
5.6	1.0096	n_1
6.7	1.011	n
7.4	1.012	n_1
8.15	1.04	n
8.3	1.029	n
9.9	1.19	n
11.7	1.4	n
14.6	1.68	n
17.6	1.85	n

The other rays separated by a prism of aluminum have not yet had the length of their undulations measured, they are those whose indices are 1.48, 1.36 and 1.29.

With a prism of 30 degrees the radiations observed are the last six of the above table (of which 1.04 and 1.029 are not separated) and the three aforesaid. A prism of 90 degrees is necessary to separate the first seven in the above table.

Jean Becquerel has been able to show, in the lengths of undulations thus measured, the existence of two series wholly analogous to those observed in the emission of incandescent vapors. The lengths of undulation in millionths of a millimeter are, one set approximately

Multiples of 2.9 by	Length measured. Bicrons.	Length calculated. Bicrons.
1	3	2.9
2	5.6	5.8
3	8.3	8.7
4	11.7	11.6
5	14.6	14.5
6	17.6	17.4

And others which are approximately

Multiples of 4.9 by	Length measured. Bicrons.	Length calculated. Bicrons.
1	4.8	4.9
$^4/_3$	4.8	6.5
$^3/_2$	7.4	7.35
$^5/_3$	8.15	8.16
2	9.9	9.8

Are these bands due to the emission of the lamp, itself discontinuous, or to a selective absorption of aluminum, or to a selective action of the n-rays upon sulfid? We have yet to learn.

At the same time that the n-rays are dispersed by a prism of aluminum the existence of other rays is shown, which, in place of increasing the brightness of the sulfid or that of the spark, on the contrary, diminish it; these are the rays which Blondlot named n_1. We have already spoken of them several times above.

Jean Becquerel has shown that when a body emits in a certain direction the n-rays, it emits in the normal direction the n_1-rays. This is the case with a body properly isolated, Rupert's drops, or a stretched wire. Thus, when one observes the action of a Rupert's drop the latter is seen to emit n-rays normally at its lateral surface and n_1-rays in the direction of its length. This fact is observed likewise at the point where the drop begins to swell. The laws relative to both n and n_1-rays are the same in other respects.

In certain properties the n rays resemble rays of light; the velocity of propagation, reflection, refraction and polarization. In others, and "storing up" is the principal of these, it differs completely.

Bagard has shown that the magnetic field produces, when acting on polarized n-rays, rotation of the plane of polarization and that rotary active substances act upon them the same as upon light.

But we have now to touch on a series of properties which distinguish n-rays from light. First of all we have the property pointed out by Charpentier for certain n-rays of being conducted thru metals. A metallic wire ever so long produces but a feeble diminution of their intensity. Bichat has shown that in the metals the propagation occurs as in a luminous fountain. The wire permits the n-rays to escape when it is oxidized on its longest part or when it presents a bend at an acute angle. Charpentier at the same time pointed out that when a metallic screen is placed in the path of the n-rays and grounded by a metallic wire the flow will be entirely arrested. Here are two properties which already seem to differentiate completely the n-rays from light. But all the n-rays do not serve equally for these experiments.

Jean Becquerel has shown that all the n or n_1-rays have another property which distinguishes them completely from light and allies them more closely with the kathode rays; it is that they are modified by the magnetic field. A pencil of n-rays in a magnetic field is decomposed into a series of pencils which revolve in the magnetic field, following circumferences of different radii of curvature. One ought to say that in all probability these radiations are due to rays analogous to the beta-rays of radium, for the form of deviation is precisely that given by the beta-rays (kathode streams).

When one searches with a phosphorescent screen at a distance of ten to fifteen centimeters from the point of entrance of the rays in the magnetic field, and uses a small screen mounted on a handle, he sees that he has also, very near the point of entry, some of the n_1-rays, deviated in a way inverse to that of the n-rays, but

which are rapidly absorbed by the air. They have, therefore, the same properties as the alpha-rays (streams of positively charged particles) of radioactive bodies. But a deeper study shows that there are not so many of the n and n_1-rays after traversing the magnetic field, that they are, for the most part, and probably solely, beta and alpha-rays. In short, we know that above all the beta-rays excite phosphorescence and that the alpha-rays diminish it. The first behaves like the n-rays, the second like the n_1-rays. The fact of the considerable absorption of the n_1-rays, due to the action of the magnetic field, while, normally, they are spread in the air without sensible absorption, shows that by the action of the magnetic field the n_1-rays are profoundly modified. This considerable absorption increases their resemblance to the beta-rays.

When one studies exactly with a phosphorescent screen the prolongation of the incident pencil he perceives that where the magnetic field exists he has nothing, or next to nothing, in that direction.

It can not be said that no radiations are propagated in this direction; on the contrary, if beta-ions are joined to it, an n-ray deviates; if alpha-ions are joined to it an n_1-ray deviates. Jean Becquerel accomplished the first by placing in the path of a non-deviating radiation a small piece of radium; he accomplished the second by replacing the radium by polonium.

Moreover, this ray which is not deviated by the magnetic field is susceptible of being reconstructed from n or n_1-rays by the addition of suitable ions susceptible of dispersion. It suffices, to convince oneself, to let it fall upon an aluminum prism. If, afterward, this prism is replaced by radium, one observes a whole series of n radiations dispersed, as in the experiment of Blondlot, and if polonium be substituted for radium one will see n radiations transformed into n_1 radiations.

According to Jean Becquerel an n-ray is formed by an electro-magnetic radiation analogous to light, of a very short wave length, which carries with it negative ions; an n_1-ray is composed of the same radiations bearing positive ions.

This explanation of the physical properties of the n-rays will be brot to an end by reference to a paradoxical property possessed by the sources of n-rays when subjected to the action of chloroform. When the vapors of this anesthetic reach a source of n-rays, such as isolated quartz or isolated sulfid of calcium, the n-rays emitted by the source employed will be seen to diminish, then die out.

THE PHYSIOLOGICAL ACTION OF N-RAYS.

Heretofore we have described only those actions of the n-rays which really enable us to observe them. When the n-rays act upon a source of light somewhat intense they augment the brightness; the n_1-rays, on the contrary, diminish it. Blondlot has observed the fact, as has already been mentioned, on plates of platinum rendered incandescent by an electric current, and upon sheets of paper suitably illuminated.

The experiment is made as follows: Gaze at the surface of white paper bearing a large black streak, or, better, a clock face on a wall somewhat darker than the latter. Then lower the curtains of the room so that the hands of the clock are just visible. Then turn on the source of the n-rays and the hands of the clock or the black streaks will reappear. On repeating this experiment a little differently Blondlot found that the action is produced equally when, in place of causing the sources of the n-rays to act upon the illuminated surface, they are made to act upon the eye itself. It is clearly seen that

it is the modification of the n-rays emitted by the slightly illuminated surface which produces the modification of the apparent brightness. Jean Becquerel has proved this fact by watching the phosphorescent sulfid traverse a screen of distilled water, opake to the n-rays. He has been able to ascertain, in this case, that the variations of brightness of the sulfid were, if not wholly suppressed, at least diminished in a considerable degree. This demonstrates the fact previously stated or, at least, it shows that it includes the greater part of the phenomenon.

The n-rays do not act directly upon our retina to produce the sensation of light, but they act so as to modify the excitability of our retina for the light. Besides, as Jean Becquerel has found, when a body is struck by the n-rays it throws off from itself n-rays at right angles to its surface and n_1-rays tangentially; the reverse effect is produced when it is struck by n_1-rays.

The sensibility of the eye is especially modified by the blue (Gutton) whenever the n-rays are active; the physiological nature of their action explains the failure to discover the n-rays by photography of the surface of the phosphorescent sulfid. In consequence, if we are able to augment the brightness of the surface of the sulfid observed normally, it is not because its luminous emissions are modified, but because its n emission is augmented. The latter do not act upon the plate, but solely upon the eye.

But there are some procedures which do reveal the n-rays objectively; we have already seen one, a photograph of the spark, made by Blondlot himself. There is still another, that of Rothé. When a spot of isolated sulfid is placed a little distance, for example 5 mm. from a photographic plate, we see on the latter a light and soft impression. The diameter of this impression is seen with great exactness. The diameter will be found larger in proportion to the brightness of the sulfid. On repeating this operation every twenty seconds, giving an exposure of five seconds, we obtain spots of diminishing diameters, and these diameters, by their decrease, give an idea of the decrease in brightness of the sulfid. When there is no activity of the n-rays, there is found a regular diminution in diameter of the impression of the spots.

In this operation, let the n-rays act for thirty seconds, take an impression, then leave the sulfid to itself for thirty seconds, then take another impression. Repeat these operations several times in alternation. The form of the curves will be found to be deeply modified. The velocity of the action of the n-rays diminishes in proportion as the phosphorescence decreases.

These experiments of Rothé show that in addition to the influence exerted upon the n-rays emitted by the sulfid, there is another action, that upon the true luminous emissions, disclosed by photography, as has been proven by Jean Becquerel. Ordinary photometry ought to show this action, too. It seems to be limited to the first two or three minutes of the experiment.

It is, therefore, proper to say that the greater part of the phenomena set in play by n-rays are physiological phenomena. This study will be continued by noticing their action on organs other than the eye.

Above all, they act directly on the central nervous system. Blondlot's experiment on vision with the clock-face will succeed equally well, as has been shown by Charpentier, if, in place of causing

n-rays to act upon the eye, they are made to act directly upon the center of vision of the occipital circumvolutions.

In these circumstances, Charpentier has proved a pupillary dilation thru the action of n-rays. This action alone is sufficient to explain the augmentation in luminosity and to explain why the latter is not always well seen, which is a notable feat when dealing with such a feeble, ambient light.

Charpentier has shown another action of the n-rays, that on the olfactory nerve. The acuity of the latter is increased by n-rays in a like manner as vision.

In short, he has shown that the n-rays were conducted along the nerves, or, at least, excited along them a very noticeable effect. On applying a source of n-rays to a collateral nerve, of a finger for example, there will be perceived, by means of a phosphorescent screen, an augmentation of brightness over the cerebral center corresponding to the motility of the finger impressed. No direct action is perceived, but the emission of the n-rays by the corresponding nerve center is deeply modified.

The inferior organisms are equally sensitive to the n-rays. It is by means of these that Richet has shown that in lactic fermentation there is first an acceleration of action followed by a diminution of the rays emitted by the phosphorescent sulfid.

Lambert and Meyers have discovered a retarding influence of the n-rays on the germination of garden-cress and likewise on the digestion of fecula by the saliva.

It appears that the n-rays ought to have considerable influence on the phenomena of life; their presence in great abundance in solar light and their absorption by water furnishes a clear explanation of the facts relative to climate and to mountains.

THE PHYSIOLOGICAL RAYS OF CHARPENTIER AND THEIR APPLICATION.

We have already alluded to the existence of these radiations—we will now point out their principal properties. First of all, when a phosphorescent screen is brot near to the body, either of an animal or plant, the luminosity of the sulfid is augmented. It is soon perceived that the luminosity varies, following the points of the surface of the animal under examinations. At first sight the luminosity is seen to be augmented to the maximum when the screen is contiguous to the nerve centers of the brain or medulla. In order to go farther off it is necessary to employ a "récepteur à localisation," formed of a lead tube with an interior diameter of about 5 mm., opake to the n-rays, provided with a phosphorescent screen at one end. In these circumstances, if the free extremity of the tube be applied opposite the source of the n-rays under examination, the screen will be impressed by that part of the source which is found immediately below the opening; the parts situated without emit rays which are absorbed by the lead and hence do not reach the sulfid. It is thus possible to study the localization of the centers of emission of the n-rays. Certainly, the lead should, as we have seen, store up the n-rays, but this is a tardy phenomenon which does not mask the more rapid phenomena which we are now going to study.

When, under these conditions, the free end of the tube is placed upon any part of the body, it is easy to outline the paths of the nerves, which emit a greater number of n-rays than do the neighboring tissues. Likewise, the muscles in contracting emit more than the same muscles in repose. The latter rays are able to pass thru lead in a slight degree, and also thru pure water; unlike the radiations from

the brain, which, according to Charpentier, are slightly arrested by aluminum.

Thus it is easy to outline the area of the heart, to see the workings of the various cerebral centers, especially the center of articulate speech. It is also possible, by placing the localizing tube upon the cranium and along the spinal cord, to see, while the individual submitting to the experiment is reclining and the muscles relaxed as much as possible, remarkable variations in brightness. These correspond, on the skull, to the cerebral fissures; along the vertebral column, to the centers of activity in the medulla. Above all, the cilio-spinal center and the genital center may be distinguished clearly.

During normal sleep the phenomena are not sensibly changed. During anesthesia, on the contrary, at the moment of profound narcosia the brain is seen to emit n_1-rays instead of n-rays. When this phenomenon appears on the spinal cord the animal is in danger of death; it then is necessary to resort immediately to artificial respiration. After death the passage of the n-rays ceases almost immediately in the warm blooded animals. According to Charpentier, they were observed, however, for several months in a desiccated frog. Perhaps the phenomena in this last case is very complex and bound up with the action of microbes.

The same writer has been able, by means of the n-rays, to study the results along an excited nerve, and he has been able to show that lengthwise of the nerve there is propagated an undulation having a wave length of 16 mm.

What seems the most curious fact in this domain of curiosities is the fact announced by Charpentier of the affinity of the n-rays emitted by the various organs and these alkaloids which have a specific action on the latter.

If a sulfid screen be placed on a box containing strychnine, for example, it is the spinal cord which gives the maximum brightness. If chloral be used, it is the brain which acts the strongest; if the box contains digitalin the heart will be found to produce the greatest action. It seems then that the alkaloids which act upon an organ are themselves capable of emitting n-rays, especially powerful under the influence of n-rays emitted by the organs themselves. This should be an indication of the greatest importance on the relations which ought to exist between the organs and their poisons.

DULL EMISSIONS.

The attention needs to be directed to certain other phenomena. Blondlot has shown still other facts which seem to be the generalization of the radioactivity of matter. He has shown that when the field about a piece of money is explored, by means of a screen of sulfid, certain well determined regions are found where the brightness is augmented. The whole phenomenon appeared as if the piece of money threw out electrical emissions, following in the air a trajectory slightly parabolic at its origin, and tending at the limit to become a vertical line.

Berthelot's idea seems to be that these emanations are due to a number of infinitesimal reactions which are produced constantly at the surface of bodies and which occur between the bodies and emanations of all kinds from living beings. These incessant reactions are visible to the eye all the time when a metallic surface is scraped. Likewise, in the case of gold, the surface is seen to lose rapidly a portion of its brightness. Platinum should be chosen, in order to have something lasting relatively to the phenomena of contact, and then cleaned with rouge.

These ideas have been verified for the

most part by the experiments of Blondlot himself. On repeating with pure metals the experiments at first made with pieces of money, he saw that all the metals, excepting lead, gave a dull emission when their surfaces are slightly oxidized and soiled; they do not give them when chemically pure and clean. Lead gives just the reverse of the above phenomena. The liquids and the crystals are the most active. The following are inactive: Iridium, platinum, gold, dry glass, melted sulfur, gypsum, chalk. The dull emanations of these different bodies are formed of three forked handles. One of these branches is positively charged, the second negatively, the third is not charged. They are divided into these three groups either by the magnetic field or by the electric field.

To make this experiment it suffices to place a thin line of phosphorescent sulfid of calcium on a table and to place at its side a piece of money on a plate. If the latter is placed hard by there is no action. If it be moved a few centimeters there will be seen, in a certain position, an augmentation of the brightness of the sulfid. It will change to its original value if you continue to move the piece of money. At the moment of maximum brightness the spot of sulfid will meet, at the intersection of the table, the parabolic trajectory of the ray issuing from the piece of money. These trajectories rise about 6 cm. above the piece which emits them and traverse a considerable number of solid bodies.

Julien Meyer has pointed out that analogous emanations, but of much greater velocity, appear to be emitted by the human body. A priori, one should know positively if the rays which we have studied as the rays of Charpentier are formed by n-rays or by the dull emanations. It is known that a part of the phenomenon is due to n-rays.

Charpentier has shown experimentally that his rays can be concentrated by lenses of quartz and aluminum. But those which we studied by placing the screen upon an organic body were something very complex, including n-rays and the three species of dull rays. The whole gave, however, a result which we teach depends upon the state of activity of the organ examined.

We believe it to be useless to attempt to give a bibliography of this question. All the memoirs may be found in the *Comptes Rendus de l'Académie des Sciences* for 1903 and 1904.

N-Rays.

The following is an abstract from a communication from Prof. R. W. Wood, of the Johns Hopkins University, which appeared in *Nature* (London), September 29th.

The inability of a large number of skilful experimental physicists to obtain any evidence whatever of the existence of the N-rays, and the continued publication of papers announcing new and still more remarkable properties of the rays, prompted me to pay a visit to one of the laboratories in which the apparently peculiar conditions necessary for the manifestation of this most elusive form of radiation appear to exist. I went, I must confess, in a doubting frame of mind, but with the hope that I might be convinced of the reality of the phenomena, the accounts of which have been read with so much skepticism.

After spending three hours or more in witnessing various experiments, I am not only unable to report a single observation which appeared to indicate the existence of the rays, but left with a very firm conviction that the few experimenters who have obtained positive results have been in some way deluded.

The first experiment which it was my privilege to witness was the supposed brightening of a small electric spark when the N-rays were concentrated on it by means of an aluminum lens. The spark was placed behind a small screen of ground glass to diffuse the light, the luminosity of which was supposed to change when the hand was interposed between the spark and the source of the N-rays.

It was claimed that this was most distinctly noticeable, yet I was unable to detect the slightest change. This was explained as due to a lack of sensitiveness of my eyes, and to test the matter, I suggested that the attempt be made to announce the exact moments at which I introduced my hand into the path of the rays, by observing the screen. In no case was a correct answer given, the screen being announced as bright and dark in alternation when my hand was held motionless in the path of the rays, while the fluctuations observed when I moved my hand bore no relation whatever to its movements.

I was shown a number of photographs which showed the brightening of the image, and a plate was exposed in my presence, but they were made, it seems to me, under conditions which admit of many sources of error.

I feel very sure that if a series of experiments were made jointly in this laboratory by the originator of the photographic experiments and Professors Rubens and Lummer, whose failure to repeat them is well known, the source of the error would be found.

I was next shown the experiment of the deviation of the rays by an aluminum prism. The positions of the deviated rays were located by a narrow vertical line of phosphorescent paint, perhaps 0.5 millimeter wide, on a piece of dry cardboard, which was moved along by means of a small dividing engine. I was unable to see any change whatever in the brilliancy of the phosphorescent line as I moved it along, and I subsequently found that the removal of the prism (we were in a dark room) did not seem to interfere in any way with the location of the maxima and minima in the deviated (!) ray bundle.

I then suggested that an attempt be made to determine by means of the phosphorescent screen whether I had placed the prism with its refracting edge to the

right or the left, but neither the experimenter nor his assistant determined the position correctly in a single case (three trials were made). This failure was attributed to fatigue.

I was next shown an experiment of a different nature. A small screen on which a number of circles had been painted with luminous paint was placed on the table in the dark room. The approach of a large steel file was supposed to alter the appearance of the spots, causing them to appear more distinct and less nebulous. I could see no change myself, tho the phenomenon was described as open to no question, the change being very marked. Holding the file behind my back, I moved my arm slightly toward and away from the screen. The same changes were described by my colleague.

I am obliged to confess that I left the laboratory with a distinct feeling of depression, not only having failed to see a single experiment of a convincing nature, but with the almost certain conviction that all the changes in the luminosity or distinctness of sparks and phosphorescent screens (which furnish the only evidence of n-rays) are purely imaginary. It seems strange that after a year's work on the subject not a single experiment has been devised which can in any way convince a critical observer that the rays exist at all. To be sure the photographs are offered as an objective proof of the effect of the rays upon the luminosity of the spark. The spark, however, varies greatly in intensity from moment to moment, and the manner in which the exposures are made appears to me to be especially favorable to the introduction of errors in the total time of exposure which each image receives. I am unwilling also to believe that a change of intensity which the average eye can not detect when the n-rays are flashed "on" and "off" will be brot out as distinctly in photographs as is the case on the plates exhibited.

Experiments could be easily devised which would settle the matter beyond all doubt; for example, the following: let two screens be prepared, one composed of two sheets of thin aluminum with a few sheets of wet paper between, the whole hermetically sealed with wax along the edges. The other screen to be exactly similar, containing, however, dry paper.

Let a dozen or more photographs be taken with the two screens, the person exposing the plates being ignorant of which screen was used in each case. One of the screens being opaque to the n-rays, the other transparent, the resulting photographs would tell the story. Two observers would be required, one to change the screen and keep a record of the one used in each case, the other to expose the plates.

I feel very sure that a day spent on some such experiment as this would show that the variations in the density on the photographic plate had no connection with the screen used.—*Electric Review.*

N-Rays.

Becquerel shows that the n-rays and n_1-rays given out by certain bodies, such as compressed wood or calcium sulfid exposed to sunlight, can be completely deflected by a magnet, while the x-rays given out by a Nernst filament are not affected even by a field of 10,000 magnetic units. The n-rays are, as a rule, like the β-rays of radium, and the n_1-rays like the α-rays of radium, except that the magnetic curvature of the n_1-rays is the same as that of the n-rays. The nature of the n-rays emitted by a Nernst filament has not yet been accounted for; they

affect the sulfide screen, but are not deflected by a magnet and have a definite series of very small wave lengths. These are refracted by an aluminum prism and seem to give rise to the α-rays and β-rays. The latter are free negative electrons, while the former behave like free positive electrons. He also describes some experiments, which enabled him to obtain either n-rays or n_1-rays from the non-deflected n-rays left after the rest had been deflected off by a magnet. A surface capable of storing the n-rays emits n-rays normally and n_1-rays tangentially, and vice versa. Nearly all physicists outside of France have remained sceptical, yet the theoretical interest of the investigations of n-rays is very great. We have apparently to deal with light of extremely minute wave length (of the size of a molecule and about one-fiftieth of the wave length of visible light). This means an enormous extension of the known spectrum in the violet direction. Taken together with the investigation of radium rays, the n-rays should enable us to get a distinct conception of the structure of atoms. In radium rays we deal with the projection and impact of electrons; in n-rays we probably have the ether disturbances which accompany these processes.—*Electrical World and Engineer.*

The Electric Charge of the Sun.

Among the many intresting topics covered by Section A papers at the International Electrical Congress at St. Louis was "The Electric Charge of the Sun," a paper contributed by Prof. Dr. Svante Arrhenius. Starting with the now well-known principle, first enunciated by Maxwell, that light exerts a pressure in the direction of its motion, the paper points out that the repulsion of comets' tails from the sun, which so long baffled comprehension, is now readily understood. The total gravitational force of the sun's attraction upon a given mass of matter, say a gram of hydrogen, is the same whether the gram is collected together into a dense compact mass, or spread out over a very large volume. But the pressure of light upon the gram mass depends upon the surface area illumined, and is extremely small when the gram mass is densely compacted, but may be relatively large when the mass is distributed over a large area. In fact, when the diameter of any spherical particle of totally reflecting matter of unit density is 1.5 microns, the particle will be in a balanced condition of force toward the sun at any distance therefrom, the gravitational attraction being equilibrated by the radiant repulsion. For spherical particles larger than 1.5 microns in diameter (sixty-millionths of an inch), gravitated attraction will preponderate; while for small particles repulsion will overcome attraction, as far as the diameter 0.008 micron, for which at unit density, the sun's radiant repulsion would probably be 2.5 times as great as his gravitational attraction.

It is suggested that when an eruption occurs on the surface of the sun, negatively electrified particles are hurled far off into space, of a size so small that they are repelled by light more than they are attracted by gravitation. If the resultant repulsive force were just equal and opposite to the ordinary gravitational attraction, it would take 68.7 hours, or nearly three days, for the negatively electrified particle of sun to reach the earth. Again, if the resultant repulsive force was 1.5 times as great as gravitational attraction, the duration of the journey to the earth would be reduced to 45.9 hours, or approximately two days. The exact length

of time would vary with the size and nature of the particle. As soon as the stream of negatively electrified particles reached the earth, the effect would be equivalent to an electric current penetrating into the atmosphere from above, accompanied probably by auroral display and by disturbances of the magnetic field amounting to what is called a magnetic storm. Observations by several different observers seem to indicate that a magnetic storm on the earth follows any violent eruption on the surface of the sun, by an interval of time of nearly two days (42.5 to 45.9 hours) after the sunspot comes directly opposite to the earth, an interval agreeing well with the above calculation.

By shooting off negative electrons into space, the sun must tend to become positively electrified in corresponding degree, and electrostatic force will aid gravitation in attracting the negatively electrified particles. When the sun's positive electrification became sufficiently great, the negative electrons would be attracted by gravitation and electric force more powerfully than they were repelled by light and the shooting off into space would stop. Moreover, all negatively electrified particles within a large range, say one-tenth of the distance of the nearest fixed star, would be drawn into the sun, thereby tending to reduce its positive charge. According to this view, therefore, the sun is a large alternating electric machine in which the period of alternation is about eleven years. During the period there is first a shooting off into space of electrons with an increasing resultant positive charge, and then a recoil or an absorption back from space of negative particles, with a diminishing charge. The earth, as a target, receives a part of the negative shower, and in its consequent electromagnetic phenomena naturally give evidence of the same eleven-year cycle, as observed. —*Electrical World and Engineer.*

The Magnetism of the Earth.

The International Electrical Congress paper, by Dr. L. A. Bauer, in Section A, forms an important contribution to the textbook literature of the earth's magnetism. The study of the earth's magnetism is the oldest magnetic research on earth. It is a wonderful riddle and several centuries have successively made guesses at it without much success. Nevertheless, the nineteenth century accumulated a large mass of information concerning the superficial distribution of the earth's magnetism. A number of sets of magnetic charts have thus been produced, for different periods of the century, showing the declination, inclination and intensity of the earth's magnetism at nearly all parts of the world except near the two poles. Curiously enough, the magnetic observations accumulated over the ocean-covered areas of the earth have fallen off in number and in precision during the last half century, owing to the general adoption of steel vessels, on which the large local deviation of the compass needle, due to the ship's magnetism, makes accurate measurements of the earth's magnetic field at sea almost impossible. The steel vessel has driven the natural magnetic field off the sailor's path as completely as the trolley car has driven the magnetic observatories on land away from the haunts of civilized man.

The paper points out that it is not difficlt to show that much the greater share of the earth's magnetism has its origin underground rather than above the ground. It has been shown that electric currents or magnets outside the earth can

Fig. 1.—X-ray Tube Operating Properly.

FIG. 3.—APPEARANCE OF X-RAY TUBE WHEN OPERATING AT VERY LOW VACUUM.

have very little share in the magnetic distribution at the surface which is marked on our charts. The analysis made by Gauss and others since his time of the earth's magnetic distribution indicates that about two-thirds of it is such as would correspond to a simple homogeneous magnetization of the earth's mass about an axis of symmetry which is also a diameter of the earth and inclined to the polar diameter by a moderate angle. This homogeneous magnetization has been called the primary magnetization and the share of the total evident magnetic field due thereto—the primary magnetic field or the principal magnetic field. The residual magnetization and magnetic distribution seem to be closely related to temperature distributions in and over the earth's surface. Curiously enough, a comparison of the latest magnetic observations with those made about 1840 or 1850, seem to indicate that the earth's magnetism has fallen off about three per cent during the interval intervening. The shrinkage is unexplained. If it really existed and were to continue, the earth's magnetism would almost entirely vanish in a few thousand years.

A small part of the earth's residual magnetic field appears to be due to external radial currents, i. e., electric currents passing either from the earth's surface upward into the atmosphere and beyond; or, oppositely, downward from the atmosphere down to the earth. By the application of the well-known magnetic principle that the curl of magnetic force around any area is equal to 4π times the surface integral of electric current thru the area, it has been shown that there is generally a very appreciable vertical current component to or from the earth. In other words, the curl of the magnetic force around any given territory does not in general vanish, as it should if there were no vertical electric current distribution thru the territory, but leaves a distinct residual quantity, positive in some regions of the earth and negative in others. The corresponding average distribution of current reaches a maximum of about forty milliamperes per square kilometer, either upward or downward. The paper shows that in a general way this vertical current distribution appears from the computations to be upward over those regions of the earth near the equator and elsewhere over which the atmospheric currents are known to be rising; and that similarly the electric currents appear to be downward where the atmospheric currents are generally descending. Consequently, it may be possible to account for the vertical magnetic component in the earth's residual distribution by the convective transportation of positive electricity upward or downward in the general atmospheric circulation.—*Electrical World and Engineer.*

Psychic Forces.

BY DR. C. O. SAHLER, KINGSTON, N. Y.

A little child only twelve years of age, weighing but sixty-five pounds, is able to express great psychical power. Her name is Stella Lundelius. She lives at Port Jervis, N. Y. Her first public introduction was at my sanitarium a year ago. I learned of the child through a patient from that town. This patient had heard much talk about her in her home town, but had never seen the child exhibit this peculiar power, although she had seen her many times. Being interested in this line of thot, I invited her father to pay me a visit, so the father and child came to the sanitarium and spent two days and nights with us. The father is a photographer and a very intelligent man, one who has made a good deal of investigation in his own way along psychic lines. He possesses hypnotic power. The mother of the little girl is a medium. The child is, as I said, twelve years of age, a refined, natural child. During the past year, thru the New York *Herald* and other papers, she has been brot to a great notoriety, but it does not disturb her in the least, as all curiosity and flattery have not aroused the least vanity in her nature. She has the mental-motive temperament, with a refined spiritual nature; a child who would not be singled out as one possessing any peculiar psychic power. When she appeared before the people of the sanitarium there were over a hundred present. In one evening I saw more than thirty or thirty-five different ones attempt to lift her, and fail in the attempt. The part which she played in this program was very simple. She would walk into the middle of the room, when any person had the privilege of lifting her by placing his hands under the arm pits, which to an ordinary man was a very easy thing. Then without regard to any special position, she would simply touch the neck or the wrist of the lifter with one finger, using either hand. To her this seemed to create an impression of contact and then if a man attempted to lift her he would find that he could not do it. I saw one gentleman, weighing 225 pounds, try a number of times and he could not lift her from the floor enough to slip a sheet of paper under her feet. I made the attempt a dozen or more times myself, and could not do it. When she did not touch my body with her finger I could place the index finger of each hand under the arm pits, and raise her up with ease, at arms' length, two or three feet from the floor; but the moment she put her hand upon mine, or touched my body anywhere with her finger, I could not, even with both hands, thoroly grasping her body under the arms, possibly raise her. During her two days' stay at the sanitarium, nearly a hundred people made the attempt to lift her, and all failed, with the exception of four individuals. One of these was a man who was a very gross skeptic, the other three were patients of mine, two being small in stature and all three very low in magnetic power and all three not in good health. They could lift her whether she touched their bodies or not. During the day she was around thru the city at business places, and there was so much talk concerning her that many outsiders made the attempt to lift the child, but in every instance failed. Unlike the Georgia Wonder she did not either ignorantly or intelligently resort to any law of mechanics by having some special method or position

whereby the tests must be made, but individuals pursued their own methods, merely clasping her around the body under the arms, lifting without standing up against her with their bodies, and she being of such light weight, it was no trouble to lift her at arms' length except when she willed otherwise. In making these tests she did not resort to any muscular tension or resistance, in fact, she stood almost limp, without the slightest muscular energy to combat those who attempted the lifting.

This phenomenon was first discovered by the father when she was but a little child playing on the floor. Sometimes he would discover that she was extremely heavy, and at other times stemed very light. During her childhood he always attributed it to something peculiar in himself, but as she grew a little older he discovered it had nothing to do with himself, for if others attempted to lift her she became so heavy it was with difficulty they accomplished it. After weighing these experiments I formed the opinion that it was due to her own direction of her psychic forces. I endeavored to ascertain if it was something entirely within her, or if others possessed the same power. I made tests with several individuals and I found one gentleman especially, weighing about 150 pounds, who, when given the suggestion in the hypnotic state (and by this I mean only physical hypnosis, for in every other particular he was perfectly normal) that he was so heavy a strong man would find it impossible to lift him, proved to be so. I had a number of gentlemen, one weighing over 200 pounds, and an athlete, attempt to lift him, and they could not do so, even by clasping the arms right about the subject's body or waist. I would then alternate—suggest that he was normal in weight and that an individual could lift him, then after giving the suggestion that he was abnormal the lifter would perceive the great change immediately. By these tests I proved to myself that the little girl, possibly through some hypnotic influence of the father in childhood, while in childish play, imbibed the thot from the father that she was heavy. Later, her ego endowed the body with a great amount of psychic force, which made her heavy, and this condition had been gradually developed thru childhood into girlhood.—*Suggestion.*

[A reliable friend told me of a test he made with a lady who was a similar psychic and whom he accidentally met at a railway station. When she allowed him to do so he could lift her with ease. When she willed otherwise and touched him he felt a sudden muscular weakness, and knew then that his next attempt to lift her would be a failure.

The statement that such an effort is due to "suggestion" or to "will power" means nothing. Suggestion is a term which now includes all kinds of forces that may act on the organism. But what is desirable is an investigation of the conditions which favor or hinder the exercise of such powers, with a view to their application in education and daily life.—EDITOR.]

Electrolysis and Catalysis.*

BY PROF. W. OSTWALD, M. D.

The chemical result of the conduction of an electric current thru an electrolyte is made up of two very different effects, namely, the phenomena of the *conduction* thru the electrolyte and those concerned with the *transfer of electric charges* at the electrodes. With respect to the first effect we have clear and definite conceptions based on the universally confirmed theory of Hittorf. According to this theory, the mechanism is of the greatest simplicity, namely, the kations and anions migrate in opposite directions and with mobilities which depend mainly on the specific nature of the ions, but also on the solvent, the concentration and the temperature. The process which results in the second effect—namely, the ionic discharge or the general transfer of charges at the electrodes—also seemed at first to be simple and clear. But the assumption that the ions which accomplish the transportation of the current thru the electrolyte are also the materials which undergo the electric change at the electrodes, could not be supported; it was the recognition of the very fact that both can be different, which made possible the development of the proper explanation of the phenomenon of electrolytic conduction itself. Berzelius still based his electrochemical system on such an incorrect conception of the electrolytic phenomena. He at first and chiefly tested the salts of the alkaline metals and earths; since *bases* and *acids*, besides hydrogen and oxygen, result from their electrolysis, he regarded the former two substances as the real constituents of the salts, and based his entire chemical system on this misconception derived from his experiments. Even Faraday held rather erroneous views in this regard, tho we owe to him the name and conception of the ions. The first one who was consistent was Daniell, who thruout assumed the metals to be the kations of the salts. The scientists' conception of the mechanism of the transportation of electricity by the ions was still imperfect, and it was Hittorf who then worked out the theory in this respect and reduced it to a perfectly simple and clear one; to him we owe the statement that electrolytes are salts, and the experimental methods for determining the nature of the ions in every given case, as also the ratio of their migration velocities independently of any possible electrode reactions.

The new idea of decisive importance was that of a *secondary reaction*. While by the conduction of the current thru the electrolyte a certain ion may be transferred to the kathode, it does not necessarily follow that it is deposited or liberated there. In a solution of potassium chlorid it is undoubtedly the potassium ion which transports the positive electricity to the kathode. Yet it does not appear there as the product of electrolysis, but in its stead, potassium hydroxid and hydrogen are formed. This is explained by the conception that directly or primarily potassium is deposited, which, however, can not exist in contact with the water of the solution and reacts with it, forming potassium hydroxid and hydrogen.

First of all, this view enables us to conceive the same simple mechanism for the conduction of the current thru an electrolyte, in the two theoretically fully analogous cases of the electrolysis of the salts

*A paper presented at the International Electrical Congress of St. Louis, 1904.

of heavy metals which do not decompose water, and the electrolysis of the salts of light metals which decompose water, altho both cases are apparently quite different from an experimental point of view. Another result is that the apparent contradiction of Faraday's law is avoided which, in the case of electrolysis of salts of light metals, could be found in the fact that, besides the liberation of oxygen and hydrogen, the formation of acid and alkali appear as immediate effects of the electrolysis. Finally our view gives an explanation of the fact that in some cases, instead of the secondary reactions, it is possible to get the primary products by means of a slight modification of the conditions of the experiment. For instance, in the case of the alkali metals this is possible by the use of a mercury kathode.

In the course of time the necessity has manifested itself to consider a great many reactions as secondary. The best known example is the decomposition of water between inert electrodes. Since water itself is a poor conductor, alkali or acid is added, and in former descriptions of this method it was stated that these additions are made only for the purpose of rendering the water a "better conductor." Now we know with sufficient certainty that the conduction of the current is really accomplished by the ions of the additions, and, in the case of an acid, we consider the oxygen developed at the anode as the result of a secondary reaction between the discharged anion and the solvent water, while in the case of an alkali we must assume secondary reactions even at both electrodes, namely, at the kathode the reaction between alkali metal and water and at the anode the change of the discharged hydroxyl ions into oxygen and water.

By the development of modern electrochemistry our views on these questions have been modified so as to be more precise. If at an electrode several processes are possible by means of which the transfer of electricity from the electrolyte into the electrode may take place, we have to assume that that reaction will take place for which the potential difference is a maximum. Or, in other words, if we gradually increase the e. m. f. applied at the terminals of the cell, beginning with zero e. m. f., then, of all possible ionic discharges, those will first occur which require the smallest potential difference.

However, the potential difference for any electrode reaction has in general no constant value, but depends upon the temperature and to a considerable degree upon the *concentration;* the range of the strongest influence is exclusively at *low* concentrations. If we start from "molar" solutions and increase the concentration, we can not go beyond ten times molar concentrations for experimental reasons, because more concentrated solutions of electrolytes can not in general be prepared. Within the limits mentioned, the maximum possible difference is about 0.06 volt for the electrolytic production of any constituent of these solutions out of the concentrated or out of the dilute solution. On the other hand, if we start again with molar solutions and decrease the concentration, the same difference of e. m. f. (0.6 volt) is found for every decrease of the concentration to one-tenth its former value; hence for 0.001 molar solutions compared with molar ones, it has already increased to 0.17 as a maximum, and for 0.000001 molar solutions it is twice as great. For infinitely dilute solutions it is theoretically infinite, but experimentally one does not exceed two volts.

The following important conclusion

may be drawn herefrom. If there are several possibilities for the reaction at one electrode, the chemical reaction which really occurs depends not only upon the nature of the possible chemical reactions, but also upon the concentration of the substances which are present, and by suitably varying the latter we can bring any reaction to any point in the voltage series.

Now it is a universal fact that the electrolytic process itself results in a decrease of the concentration of that substance in the neighborhood of the electrode which is involved at that moment in the electrode reaction. Hence, any such reaction has the tendency to stop by itself and to be replaced by that reaction which can and will take place as the next one with increasing voltage. Moreover, since the voltage is influenced only by the concentration *at the electrode itself*, not by the average concentration in the whole electrolyte, this "polarization" would necessarily take place almost instantaneously after the current has begun to flow, if there were not other processes which bring the exhausted kind of ion again in sufficient quantity to the electrode.

These compensating influences are of a twofold kind. First, we have diffusion which tends to make good any decrease of concentration with a force proportional to the existing concentration difference. Secondly, we may have chemical reactions which are caused by the exhaustion of the electrolytically changed ions, since the equilibrium which had been disturbed by their disappearance begins to reconstitute itself and, therefore, also tends to counteract the loss. Both compensating processes, however, start only after the loss had been established, and are, therefore, never able to reproduce the original condition. The result is always a polarization, i. e., an e. m. f. which counteracts the applied e. m. f.[1]

The value of the e. m. f. of polarization evidently depends upon the final decrease of concentration of the electrolytically changed ion. For this purpose we have to consider the stationary condition which is reached after the first variable processes have terminated. For the case in which the compensation for the exhausted ions is accomplished by diffusion only, Helmholtz has already given the underlying principles of the reaction. These may be briefly summarized as follows:

The current causes a consumption of the active ion at the electrode surface, the quantity consumed being proportional to the quantity of electricity which has passed. But the electrolytic migration of the ions does not bring as many new ions to the kathode as are consumed; it brings only a certain portion of this number, this portion being given by the ratio of the migration velocity of the active ion to the sum of the migration velocities of both ions. Hence there must necessarily result ionic exhaustion which is counteracted by diffusion. The exhaustion progresses so far until diffusion—which simultaneously increases on account of the increasing concentration difference—brings back to the electrode exactly the missing amount of ions in the form of its salt. There will, therefore, be produced finally a certain distinct concentration difference between the electrode surface and the main part of the solution, and there will be a corresponding distinct e. m. f. of polarization. Since the diffusing quantity of salt is proportional to the coefficient of diffusion and to the *difference* of concentration,

[1]There are known a few cases of abnormal polarization in which the current causes an e. m. f. of polarization of the same direction as the applied e. m. f.; their theoretical explanation is possible on the basis of the theory given in what follows.

while the e. m. f. of polarization is proportional to the *ratio* of the concentrations, it follows that with the same current density the e. m. f. of polarization must become the greater the lower the total concentration of the active ion.

These considerations hold good directly for primary electrolysis in which the current is transported by the same ion which undergoes the change of concentration at the electrode. For secondary electrolysis we have only to consider what the influence of the current will be, according to Faraday's law, upon the concentration of the electrolytic ion at the electrode. Let us consider, for instance, the case of "water decomposition," and let us distinguish the two cases in which, for increasing the conductivity, an acid or a base is added. With an acid solution we have to consider at the kathode the concentration of the hydrogen ion and we then have primary electrolysis. At the anode we had to consider first the concentration of the anion, for instance the SO_4 ion. By its reaction with water, oxygen and sulfuric acid is formed according to the equation

$$SO_4'' + H_2O = H_2SO_4 + O,$$

i. e., this process yields sulfuric acid which disintegrates again into its ions. The concentration of the SO_4 ion is, therefore, not diminished but increased, and this increase corresponds exactly to the decrease of the concentration at the kathode. Diffusion will now carry away the sulfuric acid from the anode and this will lead to a stationary condition. The total result is not a compensation of the two e. m. f's. of polarization at the electrodes, but since an *increase* of concentration has a smaller influence on the potential than an equal *decrease*, we will ultimately have a polarization in the ordinary sense, i. e., the passage of the current is rendered more difficult, and this will be the case to a greater extent the higher the current density and the smaller the total concentration.

If a caustic potash solution is electrolyzed, we have a similar increase of the potassium hydroxid concentration at the kathode, due to the ionic migration, since it is not removed there from the solution, and we thus have here quite similar conditions as exist for sulfuric acid near the anode. At the anode we have, in the case of caustic potash electrolysis, the reaction $2OH' = H_2O + O$. The concentration of HO is approximately proportional to that of the potassium, but the latter decreases on account of the migration of the ions. Furthermore, immediately at the anode a layer of pure water is formed. The total result in this case is again a polarization in the ordinary sense.

All these considerations are based, however, upon the further supposition that *the chemical reactions by which the secondary products are formed occur with a speed which is infinitely great in comparison with the other processes.* This is a supposition which, while very approximately fulfilled in the cases which we have considered, yet is not necessarily fulfilled in all cases. If we have to do with reaction velocities which are not infinitely great, there arise a great many new questions which we had no need of answering so far.

It may be asked, for instance, whether at the anode in a potassium hydroxid solution, the secondary reaction $2OH = H_2O + O'$, or even $4OH = 2H_2O + O_2$ occurs, or whether we do not have a primary reaction, namely, the discharge of bivalvent oxygen ions. True, the existence of such an ion as O'' has not yet been proved; it can never exist in considerable quantities, because it soon reacts with water according to the equation

$$O'' + H_2O = 2OH'$$

and forms hydroxyl ions. On the other hand, one may state that it must always be present in very small quantities wherever hydroxyl ions are present, since the above reaction also takes place in the reverse direction, as read from the right to the left hand of the equation, and the simultaneous concentrations of the two kinds of ions are determined by the (unknown) equilibrium constant of this reversible reaction. As long as this reaction also takes place with a speed which is infinitely large compared with that of the electrolytic processes, it does not matter which reaction is assumed, since no measurable quantity is thereby influenced; it is, therefore, not possible to decide which of the different possible reactions really occurs and a discussion of this point does not fulfill any useful purpose.

Let us now imagine the possibility of rendering the reaction between hydroxyl ions and bivalvent oxygen ions infinitely slow by some means. It would then be possible to decide which of the two reactions occurs at the electrode (under the supposition that it is either the one or the other). If it is the hydroxyl ion which is discharged, the decrease of concentration, produced by a given current, will have a relatively much smaller effect than an equivalent decrease of concentration of the oxygen ion which is present in a much smaller concentration. Under equal conditions we would, therefore, get a small polarization in the first case and a very strong polarization in the second case; and by measurements of the polarization we could decide which of the two reactions really takes place.

Such means of changing the speed of a given reaction within very wide limits really exist in chemistry in what is called *catalyzers*. From this it is at once evident what a very essential and important part the catalyzers are able to play in electrolytic action. By retarding one of the possible reactions by means of a negative or retarding catalyzer, we are able to *exclude* its influence from the electrolytic process. By accelerating by means of a catalyzer a reaction which is of itself slow, we can *include* it in the electrolytic process. In other words, we are no longer compelled to let the current act in the way stated by the above simple law, but, in principle, we are now able, *by applying suitable catalyzers, to prescribe to the current that reaction which we want to have to take place,* and it does not matter at which point of the voltage series this reaction is situated.

This fundamental idea may be applied in two directions. First in *synthetic* work; if we suppress by negative catalyzers those reactions which would take place before the desired one, we can bring the desired reaction to the front; or if the reactions which take place before the desired one occur with a low speed, we can accelerate the speed of the desired reaction by means of a positive catalyzer and can thus produce the same effect. The second application is *for analyzing the reactions which really take place at the electrodes.* If these reactions are essentially influenced by a certain addition, and if we know the single reaction which is altered catalytically by the addition, we can conclude that this reaction takes an essential part in the electrode process. If a catalyzer of known specific activity does not influence the electrode reactions, we can draw the reverse conclusion and state that that reaction is not a part of the electrode process.

In connection with this, it should be emphasized that what is called above briefly *the electrode process* is in reality a

rather complex phenomenon. In the simplest case—for instance, in the primary electrolysis of a silver salt—this reaction consists in the change of the silver ion to metallic silver. But "metallic silver" is not a well-defined substance, since we know elementary silver in very different allotropic states. Here the very general rule manifests itself that a system, when changing from one state to another one, first assumes the unstable intermediate states which change step by step into the more stable ones; in the case of explosive antimony, detected by Gore, it is well known that one of these states remains metastable for a longer time. One may say, therefore, that the first product in the cathodic deposition of silver is that which is formed as the next step from the silver ion after the loss of its positive charge, i. e., silver dissolved in water, probably of the molecular weight of Ag. On account of the presence of white metallic silver the silver can not continue to exist in this state, but changes into the stable form of white silver. At the kathode a distinct proportion of dissolved silver ions to dissolved silver metal will, therefore, be established, and this proportion will determine the potential by means of an equation similar to that given by Peters[2] for the potential of a mixture of ferrous and ferric salts. The greater the speed of the change of dissolved silver into the white solid metal, the smaller will be the concentration of the dissolved silver metal and the more it will approximate that which is given by the self-solubility of white silver[3] and which, therefore, represents the equilibrium potential of a silver electrode.

Similar considerations hold good for the secondary reactions at an electrode. Thus, as the primary anodic product of the electrolysis of dilute sulfuric acid, a substance SO_4 may be assumed which reacts with the solvent water with any (probably very high) speed, to form oxygen and sulfuric acid. In the case of concentrated sulfuric acid, which contains mainly the ion $H'SO'_4$, is is not the substance HSO_4, but its polymerisation product $H_2S_2O_8$, which is obtained, or its ions, as the conceivable primary product. If, however, the anode has too strong catalytic properties, for instance, if it consists of a large platinum plate, the persulfuric acid which is formed soon disintegrates into sulfuric acid and oxygen, and the unstable intermediate product does not remain.

It will thus be seen that even the simplest electrode reactions are made up of a plurality of reactions following each other step by step. Since each of the same can be influenced catalytically, it is already evident that a very great variety of results is possible. We should furthermore consider that many of the unstable substances which are formed as intermediate products during electrolysis, and which quickly disappear, are not yet known separately with respect to their properties, and especially with respect to the action of catalyzers upon the same. Under these circumstances it will be evident what an abundance of peculiar and unexpected phenomena we may hope to detect in this way, and how much new knowledge we may expect to obtain from a systematic investigation of this field. The literature of electrochemistry already contains a great number of separate facts which are not only understood more easily, but applied with greater safety, if considered from the points of view given in this pa-

2. *Zeit. f. Phys. Chemie*, v. 26, p. 200, 1898.

3. Such a solubility must be assumed in any case. This follows from general reasons and from the facts, detected by Naegeli, of the accumulating poisonous action, the "oligodynamics" of water in contact with metallic silver.

per (a large portion of which was suggested by other scientists, since, about six years ago, I emphasized the necessity of taking into consideration catalytic action in the investigation of the phenomena of electrolysis). I regret that I can not go into details; I wish to remark only that for some time Professor Luther, with his scholars, has attacked this problem from different sides; the papers already published by them, and still more the unpublished investigations, will show the generalty and variety with which this scientist has understood developing this principle and rendering it useful.

New Theory of Cancer.

It is not so long ago that a foremost scientist expressed himself doubtful as to whether the secret of the cancer-cell would ever be solved; it is therefore encouraging to encounter a new plausible theory, based upon accurate observation. In brief, G. Kelling (*Muench. med. Woch.*, June 14, 1904) believes with the older authors that the cancer cell is an embryonal cell endowed with all the energy of growth of young tissue; his theory differs, however, in that he does not regard it as a modified normal cell, but as altogether foreign and introduced from withouf. Thus, embryonal cells are often ingested in raw eggs and the larvae of certain fish form a staple article of food. It is even possible that insects may inoculate these cells directly into the blood. Numerous experiments bear out this view, and the author was able to produce malignant neoplasms (malignant adenoma, carcinoma and sarcoma) in every case where comminuted embryonal tissue was injected into the veins of dogs. Still more convincing proof was obtained by the precipitation test. several pyloric cancers, removed at operation were communicated and injected into rabbits in increasing doses. The serum of these animals precipitated the extract of the cancer employed, human albumin and chicken albumin, but not albumin from any other source; thus making it exceedingly probable that the cancer cells took their origin from the embryonal tissue of ingested eggs. In support of the heterologous origin is the fact that nobody has observed the transition of normal into malignant epithelium even in the most early growths. It is a well known fact in biology that all cells of one species possess the same number of nuclear chromosomes; cancer cells differ, however, in this respect from the other cells of the body. Furthermore, the cells behave differently toward x and radium rays and possess a different osmotic pressure, and there can hardly be any doubt that they are foreign. —*Medical News.*

Spleno-Medullary Leukemia Cured by the X-Ray.

BY THOMAS B. EASTMAN, M. D., INDIANAPOLIS, IND.

The reduction of the spleen to a size at least approaching normal is a *sine qua non* as in the cases observed where death finally resulted the spleen could not be materially reduced. In short, the blood count is not always an infallible index of the patient's condition or of the prospect of cure.

The patient was a young man twenty-one years of age, thin, pale and giving every evidence of profound exhaustion. He gave a history of being quite well up to the time he had spent several months in a lumber camp in Arkansas, where malaria was prevalent. Some time before he left the camp he noticed on the left side, under the short ribs, an enlargement which gradually grew in size until when I saw him the tumor occupied the entire left abdomen from a point on the level of the ensiform cartilage to Pouparts' ligament and extending two inches to the right of the umbilicus thru its entire inner border.

There was pain and tenderness over the mass; the notch could be distinctly felt. The pulse was 110 and full in volume. The apex beat of the heart was heard an inch above the normal point. He was very short of breath. There was edema in the feet. He had had nose bleed. There were few gastro-intestinal symptoms. He complained of headache and was so dizzy that he could not stand alone. His temperature was 100.6. Having no means at hand for examining the blood, I made a provisional diagnosis of spleno-medullary leukemia and put him on arsenic, quinine and tonics. There was no improvement.

On reading the report of a case of spleno-medullary leukemia cured by Senn by the x-ray I determined, after having had the young man examined by Dr. Frank B. Wynn, to give this treatment a trial.

An early blood count showed the following: Red cells, 3,000,000; white cells, 1,110,000. Differential count: Myelocytes, 11 per cent; eosinophiles, 2 per cent; normoblasts were present in small number, averaging about two such cells per field, No. 7 Leitz lens. A few erythroblasts were seen, polymorpho-nuclears, 67 per cent; lymphocytes, 18 per cent. In cover glass preparations this blood presented a picture not to be mistaken. The ratio of whites to red, about one white to every three red cells, the presence of large numbers of myelocytes, the presence of a large number of eosinophile cells and nucleated red blood cells fully confirmed the clinical diagnosis of leukemia of the spleno-medullary variety.

Without receiving any treatment whatever other than the x-ray treatment, he began to improve. A medium vacuum tube was used over the region of the tumor and the ends of the long bones ten minutes daily. The condition of his blood improved. There was marked decrease in the size of his spleen.

The patient desiring to be nearer home, the treatment was continued by Dr. J. P. Hetherington, of Logansport. About the fifteenth week of treatment the blood count did not seem so favorable as it had earlier in the treatment, altho the spleen continued to diminish in size and the patient's condition to improve. At the end of five months he was working in a lumber camp near his home. At the present time the spleen is not more than one-fifth larger than normal and the blood count is normal. He is apparently in perfect health.—*Abstracted from Denver Medical Times.*

Treatment of Tubercular Glands by X-Rays.

In the *Australasian Medical Gazette* of May 20, 1904, Beckett writes enthusiastically of this method of treatment. He says that excision can not be regarded as a cure; it is merely the best expedient to be adopted in face of a confessed inability to cure. There are two reasons why the operation has to be very often repeated: first, the impossibility of drawing any certain line of demarcation between the infected and non-infected glands; and secondly, the surgeon's knife does not attack the cause, but the effect of the disease. The infected glands are not the primary cause, but the result of infection that has been incurred elsewhere, so that if even the whole of the infected glands is removed it is quite possible for others to follow on the same course. The same thing can be seen after the removal of the tonsils by excision, as we know it is no uncommon experience to find after the tonsils have been removed that in a few months the enlargement is as great as ever. The question of disfiguring scars is no trivial one to any young woman, and many of these patients are such. On the other hand, by the x-ray treatment, if carefully done, there is no disfigurement (altho the writer admits that if care is not exercised the neck may be badly marked for a time, but this usually wears off, and can generally be avoided altogether by a careful operator). Above all, the beautiful way in which, in a suitable case, these glands disappear forces the writer to believe he is not claiming too much in describing it as a process of actual cure, which can only be explained on the assumption that the rays act not only on the glands, but also on the primary source of the disease. He invariably finds that the patient gains weight and improves in health. The only drawback is that some time and trouble is required; but the results are so much better, in his opinion, than by operation that he believes most persons would prefer it, and when the facts are better known the operations for excision of the glands will pass into the limbo of the discarded and needles operations.

In regard to the method of treatment, as so much of this work is largely a question of time and patience, nothing can be accomplished in a few days or a few exposures. The writer uses a powerful coil and a current of large amperage, giving five-minute exposures two or three times a week. As might be expected, it is advisable to use tubes in the highest practical state of vacuum to obtain as deep penetration as possible, and also because these tubes give other advantages specially suitable to these cases. In the first place such exposures are rather severe, and with ordinary low, or comparatively low, vacuum tubes the difficulty is with the dermatitis, which arises and compels the treatment to be suspended for a while. The author finds it possible to give longer exposure and can use stronger currents (that is, up to 8 to 10 amperes) before the dermatitis becomes troublesome by using strong tubes. In some cases marked pigmentation takes place, which may last for a time after the treatment is suspended, but this is not permanent, and in time, as the skin is renewed, it entirely disappears. Some modification is required in individual cases as experience suggests. In cases where suppuration has already commenced the writer's practice is to open and drain through a small opening, keeping open as long as necessary. These wounds heal readily and do not show any tendency to suppurate again.

Treatment varies in length of time according to the severity of the case; rough-

ly speaking, from one to three months is the rule, but the writer has taken longer. He also sometimes uses the high-frequency currents in conjunction, but regards the x-rays as the main factor in the cure, and that is another of the reasons why he prefers a very highly exhausted tube, as a certain amount of high-frequency currents are being given off all the time; and if a low vacuum tube is used no good effect seems to result. The enlarged glands disappear very slowly, and even at the end of the treatment can still be detected, but the improvement continues afterward until they entirely disappear. One marked feature is the decided improvement in the bodily health of the patient that takes place. They nearly always gain weight. Enlarged tonsils, which are also often present, also subside, from which he believes this treatment would be as beneficial for such cases, and might well be tried before resorting to excision. As regards the prospects of recurrence, he expected to find that would take place, but so far he has not seen it happen, and merely regards recurrence as an indication of insufficiently prolonged treatment.—*Ex.*

The Use of the X-Ray in the Diagnosis of Diseases of the Bones.*

BY E. A. CODMAN, M. D., BOSTON, MASS.

My particulr hobby in x-ray work has been "interpretation." By the interpretation of a plate I mean the drawing of conclusions from it as to the actual anatomical or pathological condition of the part which has been taken. I fear that I have neglected electrical and photographic technic shamefully, for I have felt that the thing which is worth a physician's time in x-ray work is his ability to draw conclusions from his plates after they are taken. Any man without a medical education may soon learn to take a technically good x-ray picture, but it requires an accurate anatomical and pathological knowledge to interpret one correctly after it is taken.

The structures of machines, coils, tubes, anodes and kathodes may be changed indefinitely in the next twenty years, but the anatomy of the bones and the manner in which they are affected with disease will be the same, and it is with these same diseases that experience in interpretation will prove valuable. The ultimate object is to obtain knowledge which will assist in curing the disease. To this end there are four steps.

1. The knowledge of the essential characteristics of an x-ray picture, i. e., that it is a projection or chart of the densities of the different parts of an object.

2. The knowledge of normal x-ray anatomy, i. e., the appearances made by the normal bones in an x-ray picture.

3. The knowledge of the pathology of different forms of bone disease, i. e., the exact manner in which each invades the bone.

4. The ability to reconstruct a picture of the pathological conditions in the individual case from the inferences deduced from x-ray pictures of it.

When we have a competent knowledge of these four essentials we may reason as follows:

*Read at the meeting of the Maritime Medical Association, July, 1904, and published in the Canada Lancet.

An x-ray may differ from the normal appearance of the tibia in that it shows a thickening of the cortical bone of the shaft. Since the shaft is affected, it is more likely to be syphilis than tuberculosis, which almost invariably affects the epiphysis. Since there is no loss of bone substance or formation of a sequestrum it is not osteomyelitis. The patient is young. therefore it is not Paget's disease. There is no chronic lung disease, therefore it is not osteo-arthropathy pneumonique, etc. Sherlock Holmes would have been a great interpreter of x-ray pictures.

Let me speak a little more fully of each of my four divisions.

1. *The knowledge of the essential characteristics of an x-ray picture.*—The x-ray picture or skiagraph is not like any other kind of a picture we are familiar with. I have racked my brains to try to find something to compare it with. My best definition is a chart of the densities of the different portions of an object. Stop to think a minute! It is not a shadow, for a shadow is merely an outline bounding a homogeneous interior. It is not a photograph, because a photograph shows merely outline and the surface. It is not a median section, for a median section gives no idea of what lies on either side. It is not a picture of an interior, for you may see it in portions of the object which are on both sides.

It really shows much more than any other kind of a picture with which we are familiar, for, like the shadow and the photograph, it gives the outline, and, like the median section and interior view, it gives some knowledge of what lies inside the bone. To this Maritime Medical Association I may compare it to a graphic representation of a chart of soundings where, instead of the number of fathoms, is registered, in black and white, the number of atoms which each ray meets in traversing the bone. The less the number of atoms met in each portion of the bone, the deeper and darker will be the imprint left by the ray on the plate.

One must remember that the greater the atomic weight of an object or substance the more obstruction will it offer in the path of the ray. This is equally true of each little part of that object or substance.

I need not remind you, too, that the portions of an object which are not in contact with the plate, are enlarged because the light radiates from a single point. In this, skiagraphs resemble shadow pictures.

2. *The knowledge of normal x-ray anatomy.*—X-ray anatomy differs greatly from the osteology which we learnt at the medical school. We then learnt to describe the surface of bones, and paid little attention to the density of their various parts. In the x-ray picture we recognize the bones entirely from their outline unless we happen to remember the look of their sections, but in the x-ray the outline surrounds a chart of densities instead of surface markings. In the skiagraph the sustentaculum tali and the unciform process appear as dense rings in the middle of the oscalis and unciform bone, instead of protuberances on their surfaces. The epiphyseal junctions in children appear as irregular overlapping elipses. The olecranon fossa seems like a hole in the lower end of the humerus.

3. *The knowledge of the pathology of different forms of bone disease.*—I mean by this especially, the particular modes in which each disease invades the bone. How have our predecessors in medicine learned to classify the different forms of bone disease? By the study at operations or autopsy of the different characteristics of each disease confirmed by the clinical history and the microscope. For instance,

in syphilis of the bone, they have given us the following facts:

A syphilitic bone has no odor. The x-ray can not tell us this.

Gummatous infiltration of a bone is not purulent, but a grayish or yellowish granulation-like tissue. The x-ray can not tell us this.

The surface of syphilitic bone is rough to the touch and the periosteum adheres with more than ordinary tenacity to it. But the x-ray can not tell us this.

So we might go on with other diseases mentioning many things which the x-ray will not tell us.

Those of us who have had experience do not expect to tell how a bone smells, or how it looks in cross section, or how it feels on the surface. We may, however, infer how it smells, or how it looks, and how it feels after we have found out some of the other things; for, fortunately, our predecessors have told us other things about syphilis of the bone.

For instance, syphilis almost always affects the shaft instead of the epiphysis. This we can find out from the x-ray.

Syphilis seldom forms sequestra. This we can find out from the x-ray.

When one bone in the body is affected by syphilis other bones are also. This can be found by the x-ray.

Take another disease, e. g., rickets. The x-ray tells us that the zone of ossification is broadened, that the adjacent surfaces of the diaphysis and epiphysis are irregular, that there are areas of little density in the broadened portion of the diaphysis, that there is increased cortical bone on the concave side of the distorted long bones, etc. It does not tell us whether the epiphyseal line is red or yellow, or how the concave side smells, but it does tell us enough so that we should not make one mistake in a hundred in making a diagnosis of rickets. We might then infer that the epiphyseal line is purple because we know that the section of a rachitic bone shows a purple epiphyseal line.

Let us suppose an instance and draw our deductions.

Here is a skiagraph of a tibia, showing a loss of substance in its lower end. This much we can be sure the x-ray says truly, but when we begin to infer what tissue of little density lies in that cavity where the loss of substance has occurred, we begin to tread on dangerous ground. Now we know from pathology that such a loss of substance may be caused by an abscess in the bone or a medullary sarcoma or chondroma or gumma. We examine the x-ray more closely. If it is an abscess it is likely to have a certain amount of new bone formation in its wall. This will make the abscess cavity appear to be surrounded by a dark wall. If the light area is due to a medullary sarcoma, we may see trabecula passing across it here and there, giving it a mottled appearance. If chondroma, it has probably an erosion or a protuberance when seen in the lateral view. If a gumma, probably there are other lesions in other bones.

Perhaps we shall have recourse to the clinical history for the most important evidence. I would no more make a diagnosis on the x-ray alone than I would say pneumonia on the strength of the stethoscopic examination alone. Sometimes I should feel pretty sure in either case, but I should like to hear a cough, or to see the temperature chart and a little rusty sputum before speaking positively.

I have no intention of claiming to make all diagnosis from the x-ray, but it is of great importance. What it does tell us is how the inorganic portion of the bone is affected, and this is a great assistance if our knowledge of pathology can tell us the

way each disease affects the inorganic portion.

4. *The ability to reconstruct a picture of the pathological conditions in the individual case from the inferences deducted from x-ray pictures.* This fourth requisition means a thoro knowledge of all the other three steps. One must understand the distortions which are characteristic of every x-ray picture. For instance, the x-ray picture of a cube may appear like two squares, a larger and a smaller; or like two superimposed trapezoids, varying in shape according to the angle from which the rays come. One must know how these distortions affect the normal x-ray anatomy of the various bones. One must know the pathology of each disease thoroly. Finally, one must reconstruct the cube from the larger and smaller square, the actual bone from the x-ray chart, the kind of disease from the particular way in which the bone is invaded, and the odor, the appearance, and the feeling from knowledge of pathology of the disease itself.

Is this way more difficult than deducing the appearance of the heart from what you hear of its murmurs? Can you not form a mental picture of the appearance of the kidney from your examination of the urine?

Expressed simply, my statement is this: If you know how to interpret it, a good x-ray will tell you much of the condition of the inorganic portion of the bone. Different diseases affect the inorganic portions of the bone in different ways. If you know what these different ways are you may get great help in your diagnosis from the x-rays.

Dr. Bozzali, director of clinical medicine at Turin University, has cured, by means of the x-ray, a supposedly incurable case of leukemia.—*Electrical Review.*

American Electro-Medical Society.

The executive council will admit to the program of the next meeting (December 1 and 2) papers on any branch of progressive therapeutics. Papers are expected from Dr. O. Shepard Barnum, Dr. Heber Robarts, Dr. Ivan F. Amilon, Dr. Carl Beck, Dr. J. A. Robison, Dr. H. Preston Pratt, Dr. John E. Gilman, Dr. Stuart Johnstone, Dr. James R. Hawley, Dr. R. H. Lewis, Dr. Sheldon Leavitt, Dr. D. A. Stevens, Dr. H. Perkins Fitzpatrick, Dr. F. A. Leusman and several others.

The meetings will be held in the Masonic Temple, Chicago, commencing at 10 a. m., on Thursday, December 1. This is a convenient time for those who are on their way eastward from the World's Fair formal closing.

The Sayen Tube.

By the kindness of Messrs. Queen & Co., of Philadelphia, we present to our readers colored plates showing the appearances of a high and low x-ray tube. This tube was worked out in the laboratory of Queen & Co. In the low tube the kathode stream is seen distinctly as it passes to the anti-kathode at the center. Rarely in such a tube it is possible to see a portion of the reflection of the stream as it passes from the anti-kathode to the active hemisphere of the glass bulb.

Roentgen Ray Anniversary.

The tenth anniversary of the discovery of x-rays by Röntgen will be celebrated in Berlin, April 30, 1905, when a congress will be held for the purpose of discussing the production and application of the rays. Prof. Röntgen will be present as the guest of honor.

Electro Therapy.

Lesson 16. The Fluoroscope.

BY T. PROCTOR HALL.

A considerable number of substances, under the action of x-rays, become fluorescent, giving off visible light. Crystals of calcium tungstate shine brightly, and continue to shine for some time after the exposure. Such a screen is not well adapted for a fluoroscope, for the shadows upon it interfere when there is any motion of the objects examined. Barium platino-cyanid (Ba Pt C_6N_6) is also strongly fluorescent, but its fluorescence ceases almost immediately when the x-rays no longer reach it. A black card, coated on its inner surface with these crystals, forms the ordinary fluoroscopic screen, which is placed in a black box so as to be viewed in complete darkness.

In using a high tube it is important to protect the screen from the rays that are diffused or reflected from the observer's body or from surrounding objects, which will otherwise obscure the view by spreading a diffused light over the screen. This may be done by making the fluoroscope box of some metal fairly opaque to the rays, or by placing against the screen on the side next the eyes a plate of lead glass.

These and other diffused or scattered rays are the chief difficulty in the use of the fluoroscope. If we try to see a rib, the rays which scatter from all the surrounding parts of the body help to illuminate the screen and obscure the shadow of the rib. Many of these rays may be eliminated by a lead screen placed between the patient and the x-ray tube, with an opening just large enough to illuminate the part to be examined.

The penetration of the rays must be adjusted to suit the parts to be examined. The general rule is to use a tube as low as will penetrate well the parts examined, when differentiation of tissue is desired. But in looking for opaque foreign bodies a much higher tube is advisable if the diffused rays are well screened off. The tube must in each case be adjusted by trial.

To estimate the depth of a foreign body with reference to bones near it, the limb is turned slightly back and forth about an axis parallel to the screen. The extent and direction of motion of the shadow of the foreign body with reference to the shadows of the bones, or of a lead wire upon the skin, enables a fair estimate to be made of its depth. The shadow of an object between the axis of rotation and the screen moves over a distance proportionate to its distance from the axis. The shadow of an object on the other side of the axis moves in the opposite direction and in the same proportion.

A single view with a fluoroscope thus enables one to locate a needle or a bullet, as to position and depth, while a single radiograph gives no idea of the depth.

If two distinct views are obtainable of, say, a bullet which is to be located, a convenient plan is to mark with a skin pencil an *x* on each side of the limb or part containing it, marking when the end of the pencil is apparently on the bullet, and an *o* on each side similarly with the second view in another direction. These four landmarks are ordinarily a sufficient guide for the surgeon, for he knows that the bullet is at the intersection of the line joining the o's with the line joining the x's.

In examining the motions of the heart, lungs and diaphram it is better to use a

large flexible fluorescent screen, instead of a fluoroscope, in a dark room. All clothing should be removed from the chest.

The beginner finds it difficult to distinguish between the shadows of muscles, scapulæ, etc., and abnormally dark lung shadows. Generally, shadows that are alike on each side are normal. Much information may also be gained by observing the depth, in the way already indicated. Nothing of value can be learned by an unpracticed eye, except in gross lesions, in which this gives a valuable confirmation of other physical signs. But in the hands of an expert this method is one of extreme delicacy.

The physical condition of the observer and especially of his eyes makes a great difference in the delicacy of the fluoroscopic examination. One who is tired, or who has just come out of the bright sunlight, may be unable to see anything clearly. A fresh fluoroscopic screen is also much better than an old one.

Cancer of the Mamma Cured by Roentgen Rays.

E. Schiff reports a case of inoperable cancer en cuirasse of the left mamma with lenticular metastases of the cutis. The left thorax was invaded by a tumor with large basis and of very solid consistence. The tumor extended from the left sternal margin to the axillary cavity, where it reached the glands and formed a hard bunch. The surface was ulcerated and exuded fetid matter. The lower edge showed ten or twelve small tumors, slightly bleeding. On the patient's back were five similar nodules. Beneath the bunch in the axilla there was a crateriform cavity large enough to admit a pigeon egg. The edges were gangrenous. Both supra and infraclavicular glands were hard and resistant. After the third sitting the pain decreased considerably, and the purulent secretion diminished. After five months' treatment the writer noticed that excepting some superficial excoriated parts, a flat scar crossed by some enlarged capillary vessels had taken the place of the former tumor. The cutaneous metastases had disappeared and the groups of soft glands in the supra- and infraclavicular regions had greatly decreased and were soft. The general state of the patient had very much improved. The writer then gives a description of the histological appearance of the tissues, showing that the new growth had almost disappeared at the time of examination.—*Bulletin of The Johns Hopkins Hospital.*

The Treatment of X-Ray Burns.

Mr. H. Lyle, senior surgeon to the Liverpool Hospital for Cancer and Skin Diseases, writes to the *Lancet* that he now believes them to be reasonably amenable to treatment. The method recommended is free application of an ointment composed of plumbi oxidum, one drachm; zinci carbonas, two drachms; glycerinum, one drachm; oleum olivæ, half a drachm; adeps benzoatus, to one ounce.

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